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This was done by contaminating endodontic reamers with spores, exposing them to a CO_2 laser beam, and checking for their viability by standard microbiologic techniques. It was found that 100% of the spores were killed by the CO_2 laser. This holds promise as an effective method of sterilizing endodontic instruments in the future.

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USE OF THE CO_2 LASER IN STERILIZATION OF ENDODONTIC REAMERS

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Abstract

The object of this study was to test a new method of sterilizing endodontic instruments by using a CO_2 laser system.

This was done by contaminating endodontic reamers with spores, exposing them to a CO_2 laser beam, and checking for their viability by standard microbiologic techniques. It was found that 100% of the spores were killed by the CO_2 laser. This holds promise as an effective method of sterilizing endodontic instruments in the future.

Introduction and Review of the Literature

There is general agreement that the sterilization of endodontic instruments is an extremely important aspect of endodontic therapy. The currently accepted techniques include the dry-heat sterilizer, the steam autoclave, the Harvey alcohol vapor sterilizer, ethylene oxide gas, and the salt (glass bead) sterilizer.[1-4]

The need exists for a rapid chairside technique of sterilizing endodontic instruments because endodontic instruments are quickly contaminated by contact with the oral flora and also by digital manipulation.[1] Currently the only rapid chairside sterilization technique is the salt (glass bead) sterilizer.[1-4] Unfortunately, the salt (glass bead) sterilizer is not consistently reliable.[2,5,6,7,8] Dayoub and Devine[5] have shown that six out of thirteen salt (glass bead) sterilizers did not achieve an acceptable operating temperature of 218°C. They also noted that the heat-up time of the other seven sterilizers varied from 15 minutes to 3½ hours.

Currently the CO_2 laser is being used in many areas of medicine. Stellar et al[9] have reported that living bacteria in tissue can be quickly vaporized and destroyed by the CO_2 laser beam. Adrian and Gross[10] have shown that the CO_2 laser is capable of effectively sterilizing a scapel blade which had been previously

contaminated with spores. There is also evidence to show that the CO_2 laser can sterilize a sharp instrument without significantly decreasing its cutting efficiency.[11]

The CO_2 laser is reflected by metal surfaces; however, biologic tissues absorb virtually all the CO_2 laser beam resulting in their vaporization.[9,12] Because of these characteristics the CO_2 laser may function as an effective chairside sterilization technique.

The purpose of the present investigation was to determine if endodontic reamers contaminated with known microorganisms can be effectively sterilized using a CO_2 laser.

Method and Materials

One hundred (100) endodontic stainless steel reamers* (size 40) were notched 18mm from the tip of the instrument to permit removal of the shafts and facilitate handling at the completion of the attempted sterilization procedure. The instruments were steam autoclaved at 121°C, 15p.s.i. for 30 minutes to insure sterilty. The instruments were divided into five groups of twenty instruments each (Groups A-E).

Groups A and B were contaminated with spores of *Bacillus subtilis var. niger* (ATCC** 9372). Groups C

*Kerr Manufacturing Co. Romulus, Mich. 48174

**American Type Culture Collection, Rockville, Md.

and D were contaminated with spores of Bacillus stearothermophilus (ATCC 7953). Group E was used as the sterile control. Groups A and C were used as positive controls to insure proper contamination by the spores; and, Groups B and D were radiated using a CO_2 laser system,+ after which all four groups were placed into tubes containing thioglycollate medium and incubated.

The spores were prepared using basically a method outlined by the Association of Official Analytical Chemists[13] as follows:

1. The lyophilized test organisms, B. subtilis var. niger and B. stearothermophilus, were each reconstituted in soil extract nutrient broth and incubated for 24 hours at 37°C and 55°C respectively.
2. Two sets of three test tubes, each containing 15ml of soil extract nutrient broth, were inoculated with one loop of stock culture of the appropriate test organism and incubated at 37°C for 72 hours for B. subtilis var. niger and at 55°C for B. stearothermophilus.
3. The contents of each test tube were then poured into a tissue grinder and macerated to break up the pellicle. The resulting mixture was filtered through a sterile funnel containing a moist pledget of cotton into a sterile test

+Coherent Medical, Palo Alto, Ca.

tube. This removed meat particles and allowed the passage of spores.

4. Groups A and B endodontic reamers were placed into the B. subtilis var. niger spore suspension and remained in it for 20 minutes.

5. They were removed and placed on sterile matted filter paper in glass petri dishes and dried in a vacuum desiccator containing calcium chloride for 24 hours.

6. Acid resistance of the spores was determined by the AOAC Acid test.

Groups C and D were handled in the same manner using a spore suspension of B. stearothermophilus. The instruments of Groups A and C were then dropped into thioglycollate medium and incubated to determine the contamination.

The reamers of Groups B and D were individually placed in a holding device that would allow them to be turned 360°, 90° at a time. This was done to insure that the entire instrument was irradiated. The reamers were then irradiated, for three seconds per surface, at 10W using the CO_2 laser system. The laser beam was moved along the length of the instrument during the three second period by a "joy stick" control.

After exposure to the laser system the shaft of

the instrument was removed from the handle by a sterile hemostat and placed into a tube containing thioglycollate medium. The test tubes with Group A and Group B reamers were incubated at 37°C for 21 days; and, after 21 days, they were heat-shocked at 80°C for 20 minutes and reincubated for 3 days more. The reamers of Groups C and D were incubated at 55°C for 24 days.

The sterile controls were placed in the same holding device. The shafts were removed by sterile hemostats and they were placed into tubes of thioglycollate medium and incubated in the same manner as the test instruments. Ten sterile controls were incubated at 37°C and ten were incubated at 55°C.

Results

As seen in Table 1, none of the sterile controls (Group E) had any growth; whereas, all of the contaminated controls (Groups A and C) showed growth. All the reamers which were irradiated with the CO_2 laser beam (Groups B and D) showed no growth.

Discussion

The laser beam has most of the properties of ordinary light. It is therefore capable of being blocked by an object in its path. Its action is dependent upon directly contacting the surface to be treated. It was thought that the reamer, being twisted, might block the laser beam from contacting its total surface. However, the results obtained proved this concern to be unfounded.

The two bacterial spores that were used in this experiment provided a representative spectrum of spore-formers. They are commonly used to evaluate the the effectiveness of various sterilization methods such as the saturated steam autoclave, ethylene oxide, etc.

The efficacy of using the CO_2 laser system for sterilization is not practical at this time. However, with the current rapid development of laser technology it may not only be wise but cost-effective to use a system such as this to sterilize endodontic instruments.

Conclusion

The CO_2 laser is an effective way to quickly sterilize #40 endodontic reamers which are contaminated with highly resistent bacterial spores.

Table 1. Effect of the CO_2 laser on contaminated reamers

Group	Contaminant	Treatment	Growth
A	*B. subtilis var. niger*	none	20/20
B	*B. subtilis var. niger*	CO_2 laser irradiated	0/20
C	*B. stearothermophilus*	none	20/20
D	*B. stearothermophilus*	CO_2 laser irradiated	0/20
E	none	none	0/20

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